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ARNPRIOR GS AND WABA DAM
NEW GEOTECHNICAL INSTRUMENTATION

C.B.H. Cragg

New instrumentation installations at Waba Dam and the East Dyke of Arnprior GS main dam are documented in this report.

1.0 INTRODUCTION

Phase I design reviews of Waba Dam/1/ and Arnprior GS East Dyke/2/, performed under the Dam Safety Assessment Program, recommended the installation of additional instrumentation at these sites. A detailed proposal for this new geotechnical instrumentation/3/ was prepared in August, 1987. Budget restraints allowed only part of the proposed instrumentation program to be authorized in 1987. The field installations, which were performed in October and December of 1987, are described in this report. Laboratory tests on samples obtained from some of the East Dyke instrumentation boreholes are also presented.

2.0 WABA DAM INSTRUMENTATION

New instrumentation installed at Waba Dam consisted of 18 standpipe piezometers and 2 deep settlement gauges. The upper part of existing slope indicator SI-1 was repaired. No soil samples were obtained during this work.

2.1 Piezometers

As shown on Figure 1, the new piezometers have been installed, singly or in groups, in nine locations. These locations, designated by the letters P through X to conform to the labelling scheme used for existing piezometers, are arranged in three cross-sections at chainages 15+00, 20+50 and 27+00 approximately. A typical cross-section, illustrated in Figure 2, shows three piezometers installed beneath the dam crest, two below the berm and one at the berm toe. Geonor drive type piezometers attached to steel "E" rods were used for all deep pore pressure monitoring locations. Mendes porous plastic piezometers attached to 1-1/2" PVC pipe were installed at the shallow monitoring locations at the dam crest and berm toe. Detailed information on piezometer depths, stick up, type and location is presented in Table I.

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Protective steel casings with locking caps were installed over all these piezometers.

2.2 Deep Settlement Points

New deep settlement gauges were installed beside existing foundation settlement gauges #12 and #15 shown on Figure 1. These new gauges designated 12A and 15A are located 6 ft and 2 ft respectively from the existing gauges and are 54 ft and 34 ft deep. While the documentation of original foundation settlement gauges suggests the reference rods are founded on a large concrete bulb, no concrete was encountered during the drilling for these new gauges. Figure 3 gives a schematic of the new settlement gauge construction.

2.3 Slope Indicator

Slope indicator 1 (see Figure 1 for location) had been out of service for some time due to damage in the upper section of casing. The steel protective cover and damaged plastic casing sections were removed and replaced with new parts. A specially machined coupling was used to join the new casing to the existing casing at approximately 4 ft below ground. Care was taken to ensure alignment of the internal grooves between new and old casings. Readings were taken by Civil Works on this inclinometer casing immediately after repair. The new protective cover was installed after these readings were taken.

3.0 EAST DYKE INSTRUMENTATION

Five new piezometers were proposed for the East Dyke of Arnprior GS. Four piezometers were installed due to access problems with the fifth location. Of these four, two were relocated from planned locations due to drilling difficulties. These instruments are described below. Soil samples were obtained from these piezometer holes. Results of the soil sampling and testing program are presented in Section 4.0.

3.1 Piezometers

Four Mendes plastic tip piezometers, attached to 1-1/2" PVC pipe, were installed at the East Dyke locations shown in Figure 4. As shown in Figure 5, piezometers designated "EP" (for embankment piezometer) are installed in the sand drain at the base of the dyke and piezometers designated "FP" (for foundation piezometer) are installed in the natural clay below the base of the dyke. Piezometers EP1 and FP1 were installed in their planned locations and encountered the sand drain near the anticipated depth. Piezometers EP5 and FP6 were relocated from the downstream side of the access road to the upstream side of this road when the drill rig could not penetrate the rockfill used for the road. As no sand was encountered in these holes, the piezometer tips were placed at depths corresponding to the dyke to foundation soil contact shown in construction drawings. All piezometers were covered with lockable protective steel caps.

4.0 SOIL INVESTIGATION

Samples were taken from all four piezometer holes, generally at 5 foot intervals, to help locate the installation depths for the piezometers and to provide information for future design reviews. All samples were subjected, where possible, to routine strength, classification and index tests. The test results are shown on the borehole profiles (Figures 6 to 9). Figure 5 compares the soil stratigraphy at the piezometer borehole locations to the construction drawing for the dyke. The clayey silt fill in the dyke has moisture contents between 26.7% and 40.1%, bulk densities between 104 and 122 lb/ft^3 (1672 and 1959 kg/m^3), and shear strength in the stiff range (1000 to 2000 psf or 50 to 100 kPa). The sand encountered at FP-1 (the hole drilled first) is quite dry, with moisture contents of only 4 to 7%, and is densely compacted. The natural silt below the fill is cohesive and has strength and index properties equal to or better than the clayey silt fill.

5.0 SUMMARY

Piezometers and settlement gauges installed at Waba Dam were described. Installation data for East Dyke piezometers and results of soil tests at these latter locations were also presented.

ACKNOWLEDGMENTS

Geonor piezometers were installed by the capable field staff of the National Research Council of Canada. Mr. D. Fraser coordinated the installations by NRC and ably performed all other instrument installations, repairs and soil sampling.

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REFERENCES

1. Debidin, F. "Arnprior GS - Waba Earthfill Dam - Interim Assessment of Integrity - 1986". Geotechnical and Hydraulic Engineering Department Report DR-8602, 1986.

2. Debidin, F. "Arnprior GS - East Earthfill Dyke - Interim Assessment of Integrity - 1986". Geotechnical and Hydraulic Engineering Department Report DR-8604, 1986.

3. C. Cragg memo to G.F. Smith. "Anrprior GS - Proposed New Instruments for Earth Structures". August 29, 1987.

TABLE I

Waba Dam Details of New Piezometers

Piezometer Number	Location	Type	Tube No	Depth to Tip (ft)	Stick Up (ft)	Comments
P1	15+00 crest	Mendes	-	37.5	1.5	
P2	" "	Geonor	6	76.0	0.25	under same cover
P3	" "	Geonor	5	100.2	1.3	
Q1	15+00 berm	Geonor	13	55.0	1.3	
Q2	" "	"	12	85.0	1.3	under same cover
R1	15+00 toe	Mendes	-	28.5	1.5	
S1	20+50 crest	Mendes	-	40.7	1.5	
S2	" "	Geonor	4	76.0	0.5	under same cover
S3	" "	"	3	100.0	1.5	
T1	20+50 berm	Geonor	11	55.0	1.3	
T2	" "	"	10	85.0	1.3	under same cover
U1	20+50 toe	Mendes	-	29.1	1.5	
V1	27+00 crest	Mendes	-	40.0	1.5	
V2	" "	Geonor	2	76.0	0.5	under same cover
V3	" "	"	1	100.0	1.5	
W1	27+00 berm	Geonor	8	55.0	1.3	
W2	" "	"	7	85.0	1.3	under same cover
X1	27+00 toe	Mendes	-	28.5	1.5	

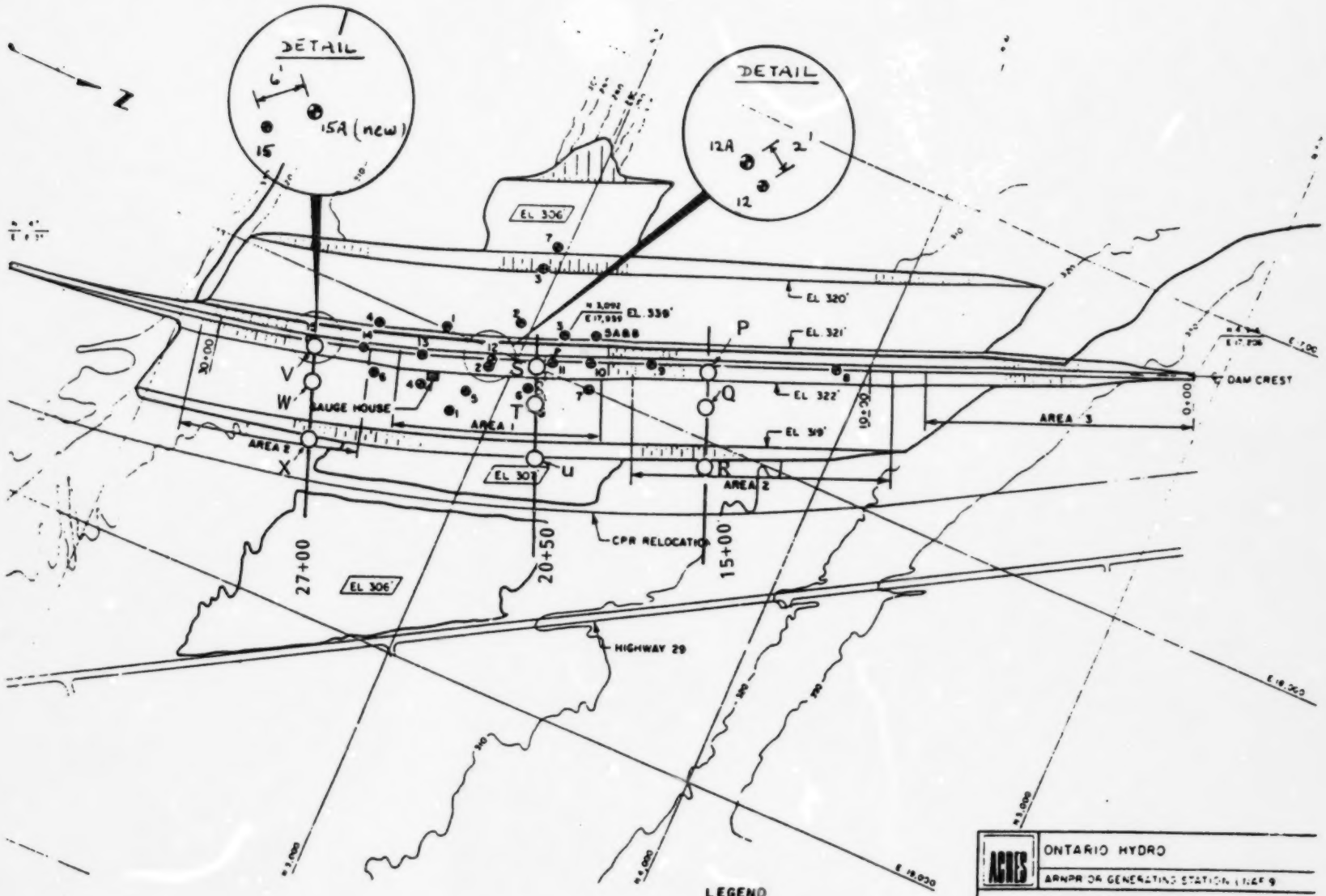

FIGURE 1

WABA DAM INSTRUMENT LOCATIONS

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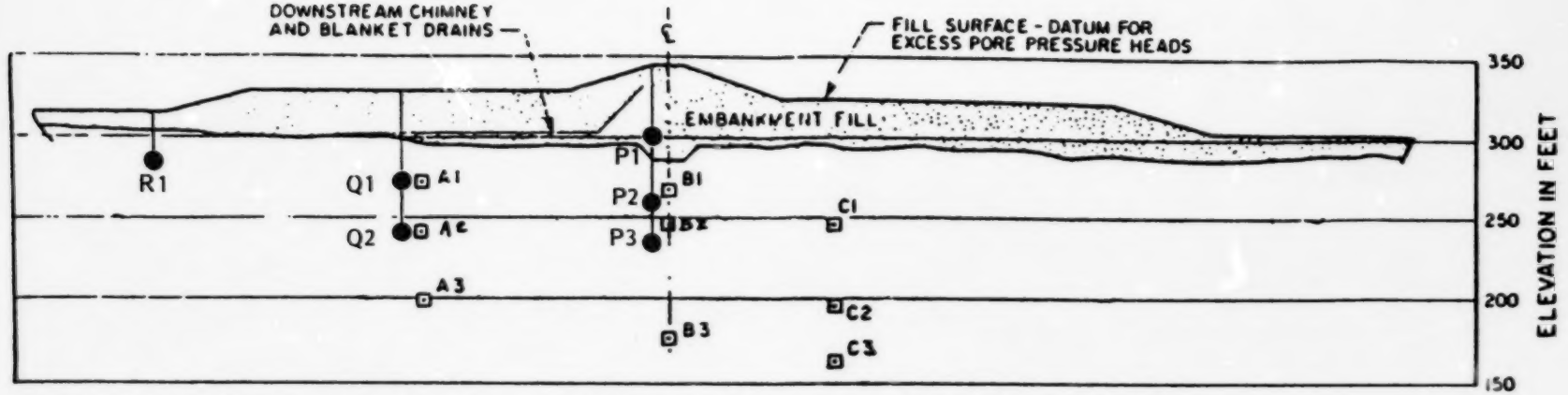

TRANSVERSE SECTION - WABA DAM THRU DEPRESSION

Legend

P1 New Piezometers

Existing Piezometers

FIGURE 2

TYPICAL LOCATION OF NEW PIEZOMETERS

176355-RD
88-5

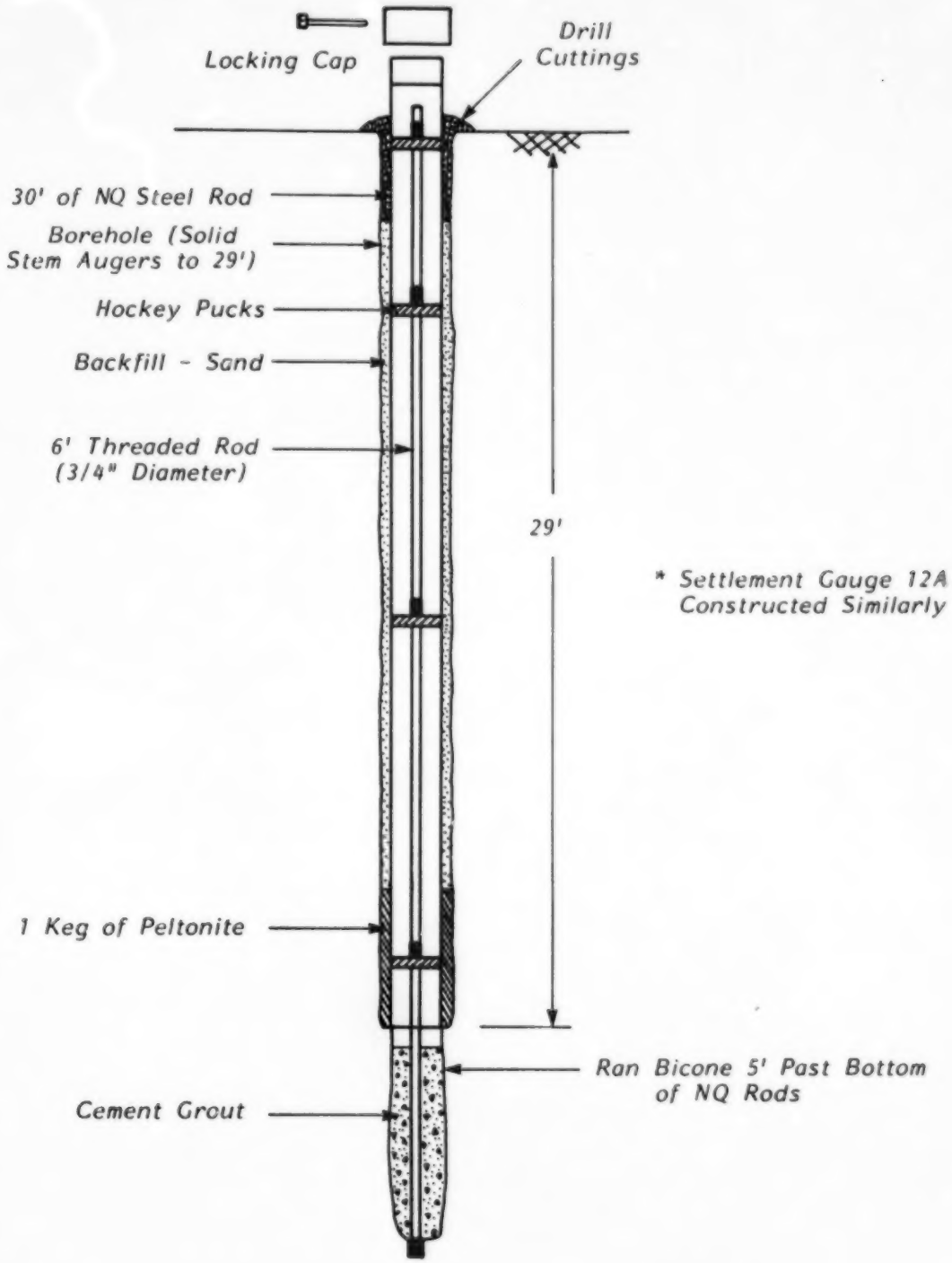

FIGURE 3
WABA DAM
SCHEMATIC OF SETTLEMENT GAUGE 15A*

176356-RD
88-5

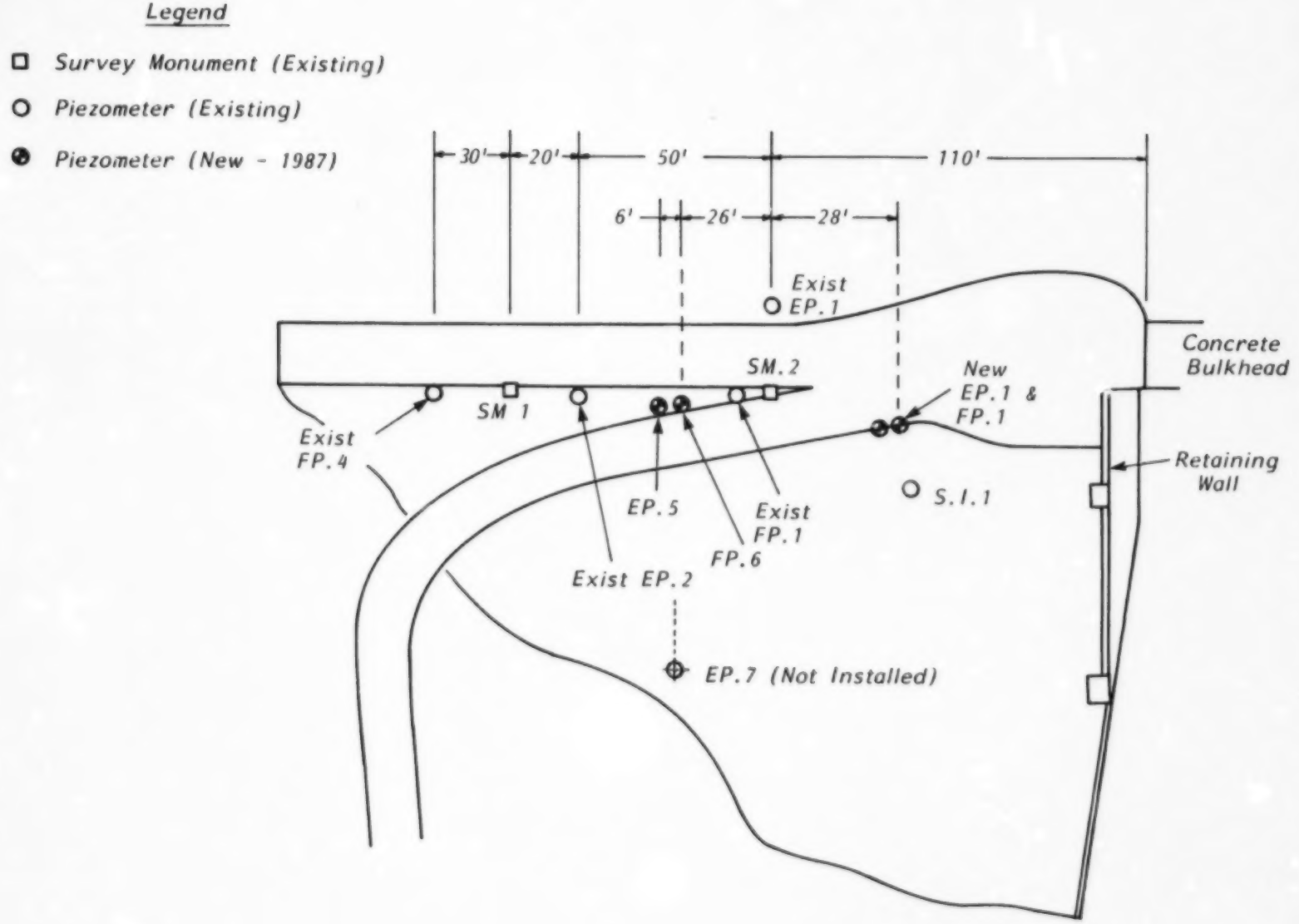

FIGURE 4

ARNPRIOR GS - EAST DYKE
PIEZOMETER LOCATIONS

176357-RD
88-5

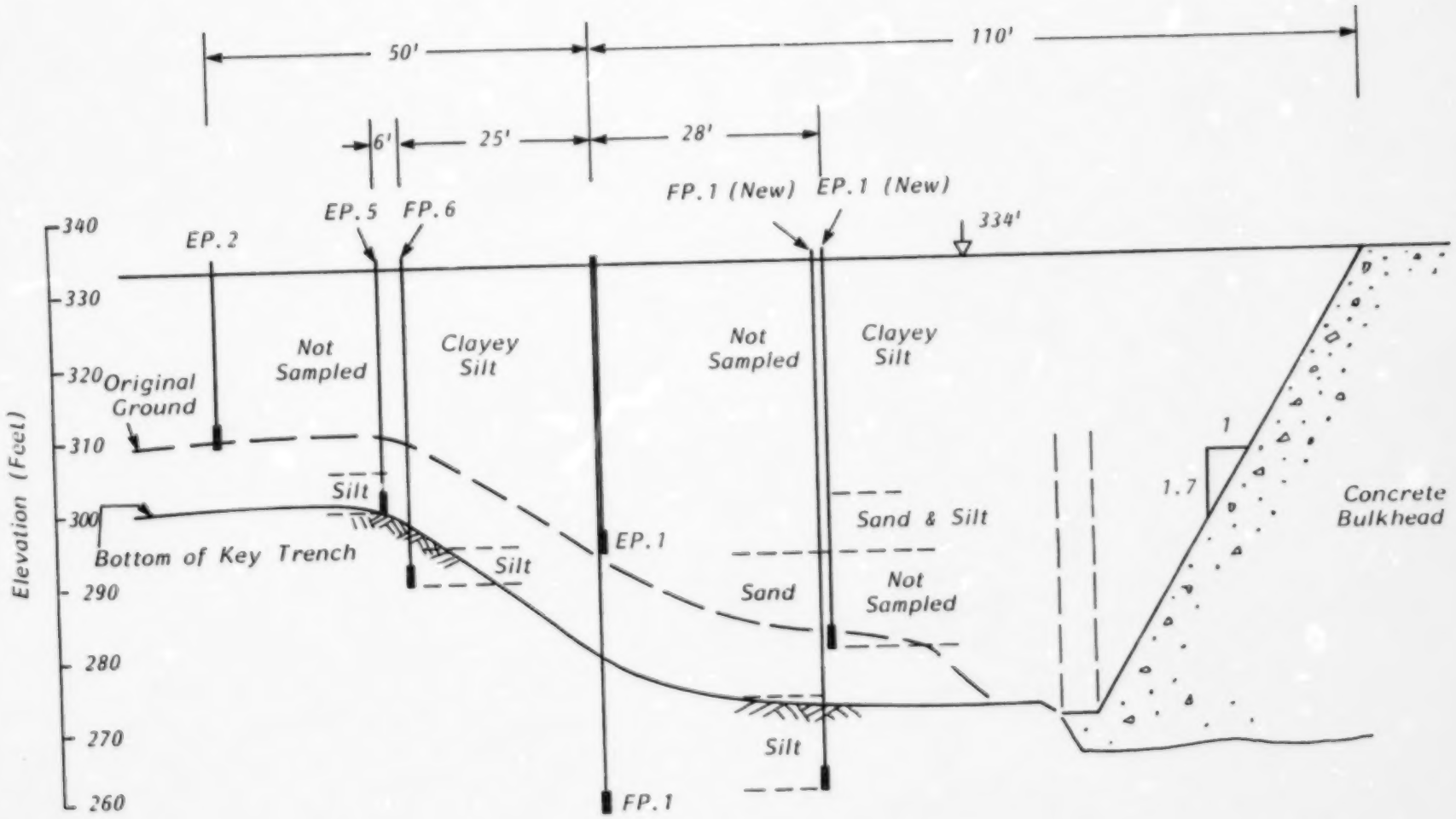

FIGURE 5

ARNPRIOR GS - EAST DYKE
SECTION LOOKING UPSTREAM

PROJECT Arnprior GS East Dyke
LOCATION Piezometer EP-1 (See Figure 4)
DATUM
DIP
BEARING
HOLE TYPE H.S.
HOLE SIZE 6"
DRILLED Dec 1/87
DRAWN
OBSERVER DSF
COMPILED CHC
CHECKED
APPROVED

BORING DATA						BORING LOG	WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - FEET	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / RQD - %	(4) WATER LEVEL and CAVING W R	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' cm/s / WATER PRESS TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS	NATURAL DENSITY kg/m³	MOISTURE CONTENT - %	(10) SHEAR STRENGTH kPa TYPE	(10) SHEAR STRENGTH kPa RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
2						SAND, Some Gravel and Cobbles											
4																	
						5'											
6		1A		13		CLAYEY SILT, Grey, Stiff						1865	33.6				
8																	
10																	
12		2A		13								1930	29.7	uc	59.5		
14																	
16		3A		13								1789	39.2				
18																	
20																	
22		4A		18									26.7				
24																	
26		5A		11								1882	28.4	uc	52.7		
28																	
30						31'											
		6A		18								1916	32.1				
32						SAND, Medium to Course, Little Small Gravel, Dense												
34																	
36		7A		31									15.2				
						38'											
38						SILT, Some Clay, Grey, Stiff												
40		8A		25								2137	23.1				
42						42'											
						Not Sampled											
53						53'											
						END OF BOREHOLE											

GEOTECHNICAL DATA SHEET

hole no EP-1 | Fig 6

sheet 1 of 1

PROJECT: Arnprior GS - East Dyke | HOLE TYPE: H.S. | OBSERVER: DSF

LOCATION: Piezometer EP-5 (See Figure 4) | HOLE SIZE: 6" | COMPILED: CBC

DIP | DRILLED: Dec 3/87 | CHECKED

DATUM | BEARING | DRAWN | APPROVED

BORING DATA					BORING LOG	WATER INF.		FIELD TESTS		LABORATORY TESTS				
SCALE - FEET	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / RQD - %	(4) WATER LEVEL and CAVING W.R	(5) DESCRIPTION / (6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' cm/s soil/rock / WATER PRESS TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS	NATURAL DENSITY kg/m³	MOISTURE CONTENT - %	(10) SHEAR STRENGTH kPa TYPE	(10) SHEAR STRENGTH kPa RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
28						See Piezometer FP-6 for Top 30'										
						30'										
30		1A		14		SILT, Plastic, Grey, Firm to Stiff, Some Clay					1854	27.3				
32																
34		2A		18							1960	35.5				
36		3A		16		36.5'						41.4				
38						END OF BOREHOLE										
40																

GEOTECHNICAL DATA SHEET

hole no EP-5 | Fig 7

sheet 1 of 1

88-5

PROJECT Arnprior GS - East Dyke | HOLE TYPE H.S. | OBSERVER DSF

LOCATION Piezometer FP-6 (See Figure 4) | HOLE SIZE 6" | COMPILED CBC

DATUM | DIP | BEARING | DRILLED Dec 2/87 | DRAWN | CHECKED | APPROVED

BORING DATA						BORING LOG		WATER INF		FIELD TESTS		LABORATORY TESTS					
SCALE - FEET	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / RQD - %	(4) WATER LEVEL and CAVING W.R	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' soil/rock cm/s WATER PRESS TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS	NATURAL DENSITY kg/m³	MOISTURE CONTENT - %	(10) SHEAR STRENGTH kPa TYPE	(10) SHEAR STRENGTH kPa RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
4						SAND, Some Gravel											
						4'											
6		1A	X	11		CLAYEY SILT, Grey-Brown, Stiff						1672	36.3				
8																	
10		2A	X	14		Zones of Silt with Some Clay						1850	33.2				
12																	
14																	
16		3A	X	12								1873	35.0				
18																	
20		4A	X	11								1795	40.1				
22																	
24																	
26		5A	X	21								1959	34.5	uc	85.2		
28																	
30		6A	X	12									29.1				
32																	
34																	
36		7A	X	13									38.8				
38																	
40		8A	X	13									36.8				
42						43'											
44						SILT, Little Clay, Little Sand, Grey, Plastic, Stiff												
46		9A	X	22		46.5'							31.7				
						END OF BOREHOLE											

GEOTECHNICAL DATA SHEET

hole no FP-6 | Fig 8

sheet 1 of 1

88-5

PROJECT Armprior GS - East Dyke | HOLE TYPE H.S. | OBSERVER DSF

LOCATION Piezometer FP1 (See Figure 4) | HOLE SIZE 6" | COMPILED CBC

DIP | DRILLED Oct 15/87 | CHECKED

DATUM | BEARING | DRAWN | APPROVED

SCALE - FEET	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / RQD - %	(4) WATER LEVEL and CAVING W.R	(5) DESCRIPTION	(6) REMARKS	WATER INF. (7) OBSERVATION WELL DATA	(8) 'k' soil/rock cm/s / WATER PRESS TEST	FIELD TESTS (9) SPECIAL TESTS TYPE	FIELD TESTS (9) SPECIAL TESTS RESULTS	LABORATORY TESTS NATURAL DENSITY kg/m³	LABORATORY TESTS MOISTURE CONTENT - %	LABORATORY TESTS (10) SHEAR STRENGTH kPa TYPE	LABORATORY TESTS (10) SHEAR STRENGTH kPa RESULTS	LABORATORY TESTS (11) SPECIAL TESTS TYPE	LABORATORY TESTS (11) SPECIAL TESTS RESULTS
						See Piezometer EP-1 for Top 40'											
	40 / 40'																
		1A		34		SAND, Fine to Coarse, Brown, Dense to Very Dense, Little Fine Gravel						1905	6.0 28.2				
	42																
	44																
		2A		60/5"		Occasional Lens of Firm to Stiff Silty Clay							6.2				
	46												6.6				
	48	3A		55/6"													
													6.2				
	50	4A		55/6"									4.4				
												1930	23.1				
	52																
		5A		46									5.1				
	54																
												2075	24.7	uc	101		
	56	6A		50													
												1890	30.8				
	58					58'											
		7A		18		SILT, Plastic, Stiff, Grey, Little to Some Clay											
	60																
		8A		20								1909	31.4	uc	85		
	62																
	64																
		9A		12													
	66					67'											
	68					END OF BOREHOLE											
	70																
								70.5									

GEOTECHNICAL DATA SHEET

hole no FP-1 | Fig 9

sheet 1 of 1

88-5